United States Department of Agriculture
Forest Service
Northeastern Area, State and Private Forestry
1992 Folwell Avenue, St. Paul, MN 55108

Reply to: 3400

Date: January 05, 1988

Robert Heyd
Michigan Department of Natural Resources
Region Headquarters
1990 U.S. 41 South
Marquette, MI 49855

Dear Bob:

In view of the formulation problems with the jack pine budworm pheromone, I think we should drop the project for now.

Bob, I appreciate your efforts in trying to make some sense out of the pheromone trap catches. Hopefully, you will be able to use some of the other data you collected to refine your budworm prediction system for Upper Michigan.

Sincerely,

JAMES B. HANSON
Field Representative
Forest Pest Management

cc:
FPM, Broomall

NATURAL RESOURCES COMMISSION
THOMAS J. ANDERSON
MARLENE J. FLUHARTY
JERRY KAMMER
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STATE OF MICHIGAN

JAMES J. BLANCHARD, Governor

DEPARTMENT OF NATURAL RESOURCES

DAVID F. HALES, Director

1990 South US-41
Marquette, MI 49855
October 13, 1988

James B. Hansen, Field Representative
Forest Pest Management
USDA Forest Service
1992 Folwell Avenue
St. Paul, MN 55108

Dear Jim:

Here is the report on the Jack Pine budworm Pheromone Study funded by your office. Of note is the last paragraph under Discussion relating to the pheromone used for this study vs the formulation used by Dr. Chris Sanders, Ministry of Natural Resources, Sault Ste. Marie, Ontario. We need to carefully evaluate and select the formulation to be used as a standard. It appears that Dr. Sanders is making significant progress in this matter. Is Dr. Sanders currently consulted or is he cooperating with the USFS program?

Few new insights were gained from this year's study. Budworm populations were low, yet more widespread throughtout the U.P. The drought surely had some influence - unclear as to what influence. We lost some 3-5 foot jack pine from jack pine budworm feeding. However, these trees were already stressed by poor planting practices and poor sites.

Let me know your thoughts on the continuation of this project in 1989.

Best Regards,

Bob Heyd

Robert L. Heyd
Forest Pest Specialist
Phone: (906)228-6561

R 1026-1
5/88

RECYCLED PAPER

1988 JACK PINE BUDWORM SURVEY SUMMARY

Region I - Michigan's Upper Peninsula

Evaluated By

Mark A. Koch

1988 JACK PINE BUDWORM SURVEY SUMMARY

Region I - Michigan's Upper Peninsula

From June through August, 1988, we conducted the third successive survey of jack pine budworm activity in the Upper Peninsula. This write-up reports and compares these surveys in an effort to gain understandings relating to the utility of pheromone trapping for predicting budworm population numbers. We are also studying the relationship of population numbers to resulting jack pine defoliation, growth loss and tree mortality. The project goal is to produce better prediction tools for managing jack pine and the jack pine budworm.

BACKGROUND

Knowledge of budworm population trends and expected damage is important in our efforts to reduce future economic losses from jack pine budworm outbreaks. Surveys of budworm defoliation from the ground and from the air are useful in comparing damage levels between stands, evaluating the effectiveness of control measures, and providing a rough idea of the expanse of an infestation. Budworm populations are monitored in the pre-adult stages to detect building populations and predict damage levels. These surveys are costly and time consuming, and often impractical when budworm densities are very low. Monitoring the adult male population with pheromone traps may offer a desirable alternative. Pheromone trapping allows managers to monitor large jack pine areas more efficiently, especially at low population levels. Theoretically, an effective pheromone trapping system can be used to monitor long-term fluctuations in population densities for long range prediction of epidemics. This would provide lead time for special operations such as establishing pre-salvage schedules and preparing marketing-utilization efforts.

METHODS

Sixteen plots located in the counties of Baraga, Marquette, Schoolcraft, Luce and Chippewa have been established as permanent impact plots for the jack pine budworm in the Upper Peninsula. Each impact plot contains 90 trees - three subplots (A, B and C) each with 30 trees. Each subplot is separated from each other by approximately 5 chains (330 feet). All plots are about 3 chains (198 feet) from secondary roads. Plot locations were mapped and plot trees marked permanently with coded metal tags.

The first of the pre-adult surveys conducted was the early larval survey. During the first and second weeks of June, thirty staminate cones (flowers) and vegetative buds

(shoots) were examined from five trees in each of the subplots. Any shoots or flowers with the presence of larvae were tallied. Samples were collected from the upper portion of the crown with a basket attached to pole pruner. Wherever possible, fifteen shoots and fifteen flower clusters were examined. When staminate cones were not abundant more shoots than flower clusters were examined. A survey of flower abundance was simultaneously taken, then recorded for each plot. The percentage of branch tips with flowers was recorded as follows:

< 30% w/ flowers = Light
31 - 50% w/ flowers = Moderate
> 50% w/ flowers = Heavy

The late larval survey (5th and 6th instars) was conducted during the third week in June. Two 15-inch branch samples were taken from the mid-crown of each of 3 trees in each subplot. Samples were collected in a basket attached to pole pruner.

During the first week in July a pupal survey of each plot was made, specifically in the center subplot B. The number and time taken to collect pupae or pupal cases from the lower branches and understory trees was recorded. If 5 pupae or pupal cases were not found within five minutes of the recorded starting time, sampling stopped. However, if 5 pupae or pupal cases were found within five minutes, the examination continued until 25 were found.

An aerial survey of all the plots was flown in mid July. The average defoliation of each plot area was described as follows:

< 20% = Light
21 - 50% = Moderate
> 50% = Heavy

After all plots were checked from the air, a ground survey of defoliation was made during late July. Ten trees per impact plot were examined with binoculars and the unaided eye for evidence of defoliation. Each plot was then ranked according to the percentage of new foliage eaten as follows:

No Observable Defoliation = None
< 20% = Light
21 - 50% = Moderate
> 50% = Heavy

Fortyeight adult traps were placed in the field during the third week in August. Subplot B in each impact plot was used as a trapping plot with the plot center comprising one of three trap locations. A trapping plot consists of three traps in a triangular configuration. Each leg of the

triangle is approximately 2 chains (132 feet) long and at least 2 chains from any roads or major openings in the forest. Where possible, traps were hung in marked trap trees 6 to 9 feet above the ground and 2 to 3 feet away from the tree trunk to permit free air flow and not obstruct trap openings. If a designated tree could not house a trap, an adjacent marked tree was utilized.

A .03% concentration of synthetic pheromone provided by the U.S. Forest Service, S & PF, FIDM, St. Paul, MN was placed in Multi-Pher traps. Numbers of male moths captured were recorded by site.

After all the population surveys were completed, tree condition within each plot was assessed. Individual trees were examined for any changes in defoliation rates, percent of live crown and general condition as to form and health.

RESULTS

Table 1 displays the results of this year's defoliation and population surveys. The average number of early instar larvae (#/15 shoots and 15 flowers, the average number of late instar larvae (#/ 15" branch), the number of pupae (# collected/5 minute interval or time to collect 25 pupae) and the average number of moths captured per trap for each permanent sampling plot can be reviewed in Table 1 and in Figure 1. Staminate flower abundance is reported in Table 1. Figure 1 is an unconventional use of graphics. All values on the dependent axis are based on separately calculated observations, which can be reviewed in the Methods section and in the previous paragraph. Thus, the results of each survey should be compared cautiously. The line used in Figure 1 is a numerical representation of the ground defoliation that occurred in 1988. Ground defoliation (% needle loss) figures are based on the representation that light defoliation = 10%; moderate = 25%; and heavy = 50%.

DISCUSSION

Pre-adult/population surveys did not correlate well with adult surveys (Fig. 1 & Table 1). One-quarter of the plots showed a positive correlation between pre-adult and adult populations. Three-quarters of the plots trapped adults without corresponding pre-adult populations. Plots 3, 4, 8 and 9 show adult populations but no pre-adult populations. Plot 7 recorded the highest average number of moths per trap. Plot 7 reflects its surroundings, a large area of multi-storied and open grown jack pine. The synthetic pheromone is apparently attracting moths from more than the plot areas.

The percent of dead/dying trees increased in plots 1 & 2 (Table 2). This is the result of two consecutive years of jack pine budworm feeding. The tree stress in these two plots is also demonstrated by the scarcity of staminate cones (Table 1).

On the whole, aerial surveys of large contiguous areas of jack pine in the Upper Peninsula of Michigan have detected very little budworm activity. However, it should be noted that due to the extreme drought in 1988, areas with light defoliation were difficult to detect aerially.

It should be noted that near plot 13, about 2-3 chains (132-198 feet) to the southwest, CANUSA was conducting an intensive jack pine budworm adult survey. Where our traps collected only a few moths (7 total), they trapped 20-30 moths per trap (Deltoid style traps). We should investigate pheromone formulations to insure use of the most effective lure.

TABLE 1
1988 Defoliation and Population Survey

Site	Defoliation Aerial	Defoliation Ground	Early Instar	Late Instar	Pupal (Time)	Adult	Staminate Flowers
1	Light	Moderate	1.7	.1	2.0	6.0	Light
2	Moderate	Moderate	1.9	1.0	24:00	4.7	Light
3	Light	None	0.0	0.0	0.0	0.3	Moderate
4	Light	Light	0.0	0.0	0.0	3.0	Light
5	Light	Light	0.1	0.1	0.0	10.3	Moderate
6	Light	None	0.0	0.0	0.0	0.3	High
7	Light	Moderate	0.2	0.1	0.0	17.7	High
8	Light	None	0.0	0.0	0.0	1.0	Moderate
9	Light	Light	0.0	0.0	0.0	6.7	Light
10	Light	Light	0.4	0.0	0.0	2.7	Moderate
11	Light	Light	0.2	0.0	0.0	8.3	Moderate
12	Light	Light	0.3	0.0	0.0	2.0	Moderate
13	Moderate	Light	0.7	0.6	3.0	2.7	Light
14	Light	Light	0.1	0.2	0.0	2.3	Moderate
15	Light	None	0.0	0.1	0.0	3.0	Moderate
16	Light	Light	0.2	0.7	1.0	2.0	Light

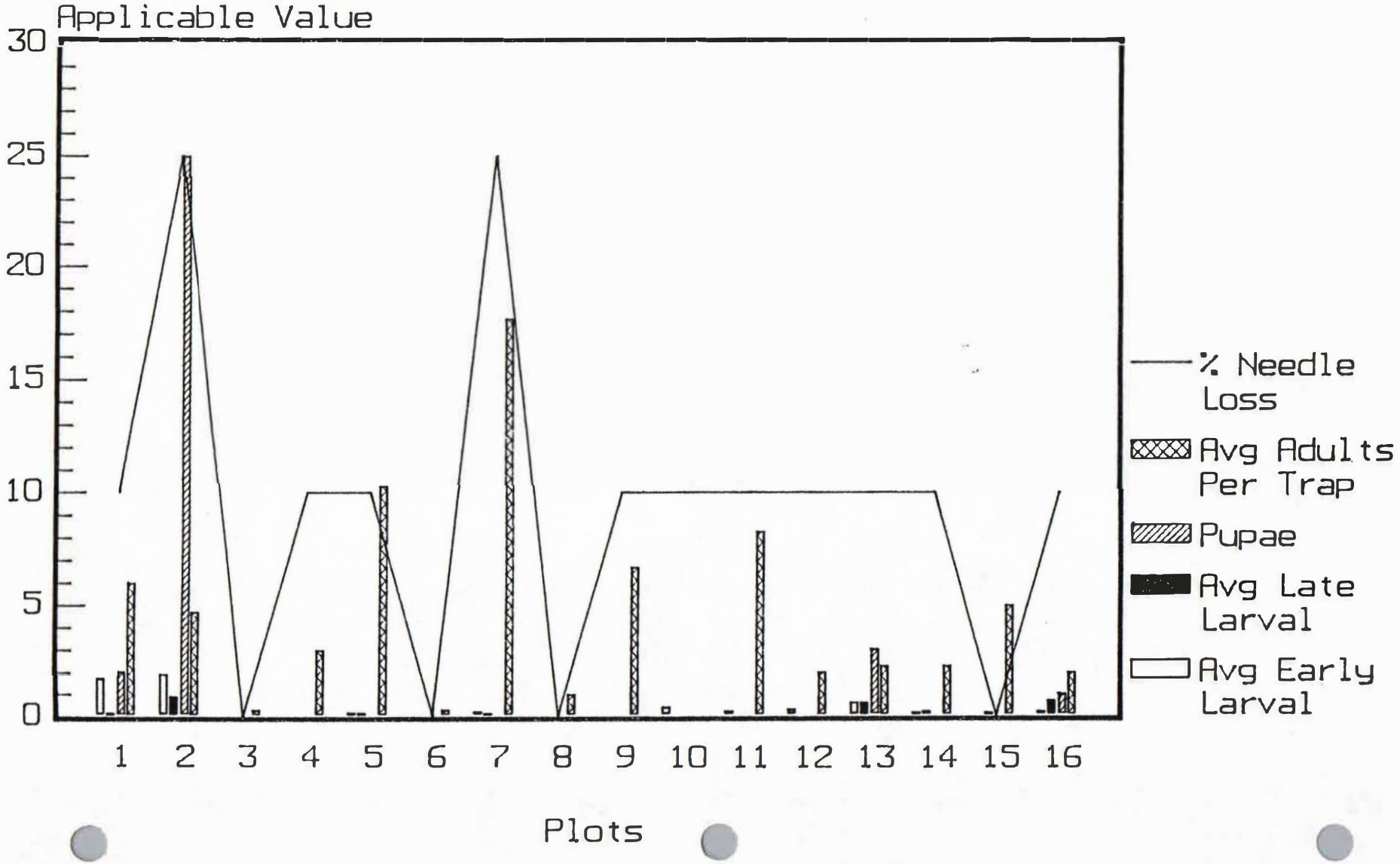
TABLE 2

Percent Change in Impact Plots From 1987 to 1988

Plot	1987 Dead/ Dying	Percent of Total	1988 Dead/ Dying	Percent of Total	Total Percent Change
1	0	0	20	22	+22
2	0	0	12	13	+13
3	7	8	8	9	+1
4	3	3	4	4	+1
5	3	3	5	6	+3
6	4	4	4	4	0
7	0	0	1	1	+1
8	1	1	1	1	0
9	6	7	8	9	+2
10	6	7	7	7	0
11	6	7	7	7	0
12*					
13*					
14	3	3	3	3	0
15	4	4	5	6	+2
16	0	0	2	2	+2

* Due to recent cutting on these two sites, impact data is irrelevant.

Figure 1
1988 Jack Pine Budworm Survey Results
Stage Summary



APPENDIX
1988 Jack Pine Budworm Survey

Defoliation Class Designation

Defoliation Class	Class Designation	% New Growth Consumed	% Old Growth Consumed
Light	1	0-25%	0%
Moderate	2	25-76%	0-25%
Heavy	3	76-100%	10-25%
Severe	4	100%	26-75%
Extreme	5	100%	75-100%

85 [illegible] Survey

Site	Tot Moths	Avg Moths
1	1	0.3
2	2	0.7
3	29	9.7
4	0	0.0
5	8	2.7
6	3	1.0
7	1	0.3
8	7	2.3
9	1	0.3
10	3	1.0
11	2	0.7
12	4	1.3
13	cut in '88	cut
14	10	3.3
15	3	1.0
16	2	0.7

86 Avg Summary JPBW

Site	Ground Def	Aerial Def	Avg Early Larval	Avg Late Larval	Pupal (Time)	Avg Adult	Percent Needle Loss
1	L	L	12.0	4.0		3.0	10
2	M	L	13.3	4.6		11.0	25
3	N	L	0.7	0.2		0.0	0
4	L	L	0.0	0.1		2.3	10
5	L	L	2.3	1.2		11.0	10
6	N	L	0.3	0.1		0.3	0
7	L	L	2.0	0.4		25.3	10
8	N	L	3.3	0.7		1.7	0
9	L	L	6.7	0.1		1.0	10
10	L	L	10.3	0.1		1.0	10
11	L	L	12.3	0.9		4.3	10
12	L	L	13.6	0.4		1.7	10
13	CUT						
14	N	L	0.2	0.4		5.7	0
15	N	L	0.0	0.0		2.3	0
16	L	L	8.0	0.6		3.0	10

198[illegible] Summary JPBW

Site	Ground Def	Aerial Def	Avg Early Larval	Avg Late Larval	Pupal (Time)	Avg Adult	Percent Needle Loss	Flower Abundance
1	M	M	12.0	3.4	25	49.7	25	M
2	H	M	14.0	3.7	25	13.0	50	M
3	L	L	0.0	0.0	0	1.7	10	L
4	L	L	0.3	0.1	0	1.3	10	L
5	L	L	0.3	0.2	1	5.7	10	M
6	L	L	0.7	0.0	0	0.7	10	M
7	L	L	0.7	0.2	1	8.3	10	H
8	L	L	0.2	0.0	0	1.7	10	L
9	L	L	0.0	0.0	1	2.7	10	M
10	L	L	0.0	0.0	0	2.0	10	M
11	L	L	0.0	0.0	0	5.3	10	M
12	L	L	0.4	0.0	0	1.3	10	L
13	CUT							
14	L	L	0.1	0.1	0	0.0	10	M
15	L	L	0.1	0.1	0	1.3	10	M
16	L	L	1.9	0.5	0	2.0	10	M

JACK PINE BUDWORM SURVEY TOTALS

Township: T49N Range: R34W Section: 31 Plot Number: 1
County: Baraga Location: West of N. Passage of 4-way
Compartment: 12 Stand: 31 Ownership: State
Timber Type: J6 State: MI District: Baraga

Survey Year TOTALS	1985	1986	1987	1988	1989	1990
Early Larval		180	180	26		
Late Larval		72	62	1		
Pupae		25	25	2		
Time (min:sec)		6:00	4:10	5:00		
Adult	1	9	149	18		
Ground Defoliation		LIGHT	MOD	LIGHT		
Aerial Defoliation		LIGHT	MOD	MOD		

Township: T49N Range: R34W Section: 17 Plot Number: 2
County: Baraga Location: W of Prison Camp Rd & Plains Rd
Compartment: 8 Stand: 27 Ownership: State
Timber Type: J6 State: MI District: Baraga

Survey Year TOTALS	1985	1986	1987	1988	1989	1990
Early Larval		200	210	29		
Late Larval		83	67	17		
Pupae		25	25	25		
Time (min:sec)		7:00	2:48	24:00		
Adult	2	33	39	14		
Ground Defoliation		MOD	HEAVY	MOD		
Aerial Defoliation		LIGHT	MOD	MOD		

Township: T50N Range: R28W Section: 18 Plot Number: 3
County: Marquette Location: S of Triple A Rd
Compartment: 6 Stand: 13 Ownership: State
Timber Type: J6 State: MI District: Ishpeming

Survey Year TOTALS	1985	1986	1987	1988	1989	1990
Early Larval		11	0	0		
Late Larval		4	0	0		
Pupae		0	0	0		
Time (min:sec)		5:00	5:00	5:00		
Adult	29	0	5	1		
Ground Defoliation		NONE	LIGHT	NONE		
Aerial Defoliation		LIGHT	LIGHT	LIGHT		

JACK PINE BUDWORM SURVEY TOTALS

Township: T46N Range: R29W Section: 26 Plot Number: 4
County: Marquette Location: Rd Connect Perch & Casey L. Rds
Compartment: 25 Stand: 9 Ownership: State
Timber Type: J6 State: MI District: Ishpeming

Survey Year TOTALS	1985	1986	1987	1988	1989	1990
Early Larval			0	4	0	
Late Larval			2	2	0	
Pupae			0	0	0	
Time (min:sec)			5:00	5:00	5:00	
Adult		0	7	4	9	
Ground Defoliation			LIGHT	LIGHT	LIGHT	
Aerial Defoliation			LIGHT	LIGHT	LIGHT	

Township: T45N Range: R28W Section: 3 Plot Number: 5
County: Marquette Location: N of Flat Rock Rd
Compartment: 29 Stand: 14 Ownership: State
Timber Type: J6 State: MI District: Ishpeming

Survey Year TOTALS	1985	1986	1987	1988	1989	1990
Early Larval			35	5	1	
Late Larval			22	3	1	
Pupae			1	1	0	
Time (min:sec)			5:00	5:00	5:00	
Adult		8	33	17	31	
Ground Defoliation			LIGHT	LIGHT	LIGHT	
Aerial Defoliation			LIGHT	LIGHT	LIGHT	

Township: T46N Range: R25W Section: 29 Plot Number: 6
County: Marquette Location: E of Dirt Rd to Gated Pvt Prop
Compartment: 79 Stand: 21 Ownership: State
Timber Type: J5 State: MI District: Gwinn

Survey Year TOTALS	1985	1986	1987	1988	1989	1990
Early Larval			5	11	0	
Late Larval			2	0	0	
Pupae			0	0	0	
Time (min:sec)			5:00	5:00	5:00	
Adult		3	1	2	1	
Ground Defoliation			NONE	LIGHT	NONE	
Aerial Defoliation			LIGHT	LIGHT	LIGHT	

JACK PINE BUDWORM SURVEY TOTALS

Township: T46N Range: R25W Section: 22 Plot Number: 7
County: Marquette Location: W of CO553, NE of Access Rd
Ownership: Marquette County Compartment: 75 Stand: 10
Timber Type: J5 State: MI

Survey Year TOTALS		1985	1986	1987	1988	1989	1990
Early Larval			30	10	3		
Late Larval			7	3	2		
Pupae			1	1	0		
Time (min:sec)			5:00	5:00	5:00		
Adult		1	76	25	53		
Ground Defoliation			LIGHT	LIGHT	MOD		
Aerial Defoliation			LIGHT	LIGHT	LIGHT		

Township: T46N Range: R16W Section: 28 Plot Number: 8
County: Schoolcraft Location: 1.6 mi E Pine Ck off M28
Compartment: 157 Stand: 61 Ownership: State
Timber Type: J6 State: MI District: Shingleton

Survey Year TOTALS		1985	1986	1987	1988	1989	1990
Early Larval			50	3	0		
Late Larval			13	0	0		
Pupae			1	0	0		
Time (min:sec)			5:00	5:00	5:00		
Adult		7	5	5	3		
Ground Defoliation			NONE	LIGHT	NONE		
Aerial Defoliation			LIGHT	LIGHT	LIGHT		

Township: T44N Range: R15W Section: 26 Plot Number: 9
County: Schoolcraft Location: E of Highwater Truck Trail
Compartment: 32 Stand: 6 Ownership: State
Timber Type: J6 State: MI District: Shingleton

Survey Year TOTALS		1985	1986	1987	1988	1989	1990
Early Larval			101	0	0		
Late Larval			2	0	0		
Pupae			2	1	0		
Time (min:sec)			5:00	5:00	5:00		
Adult		1	3	8	20		
Ground Defoliation			LIGHT	LIGHT	LIGHT		
Aerial Defoliation			LIGHT	LIGHT	LIGHT		

JACK PINE BUDWORM SURVEY TOTALS

Township: T44N Range: R15W Section: 26 Plot Number: 10
County: Schoolcraft Location: SW of Highwater Truck Trail
Compartment: 32 Stand: 12 Ownership: State
Timber Type: J6 State: MI District: Shingleton

Survey Year TOTALS	1985	1986	1987	1988	1989	1990
Early Larval		155	0	6		
Late Larval		2	0	0		
Pupae		4	0	0		
Time (min:sec)		5:00	5:00	5:00		
Adult	3	3	6	8		
Ground Defoliation		LIGHT	LIGHT	LIGHT		
Aerial Defoliation		LIGHT	LIGHT	LIGHT		

Township: T47N Range: R14W Section: 31 Plot Number: 11
County: Schoolcraft Location: W of Fox River Rd
Compartment: 30 Stand: 31 Ownership: State
Timber Type: J6 State: MI District: Shingleton

Survey Year TOTALS	1985	1986	1987	1988	1989	1990
Early Larval		185	0	3		
Late Larval		16	0	0		
Pupae		2	0	0		
Time (min:sec)		5:00	5:00	5:00		
Adult	2	13	16	25		
Ground Defoliation		LIGHT	LIGHT	LIGHT		
Aerial Defoliation		LIGHT	LIGHT	LIGHT		

Township: T46N Range: R14W Section: 10 Plot Number: 12
County: Schoolcraft Location: SW of Fox River Rd
Compartment: 123 Stand: 23 Ownership: State
Timber Type: J6 State: MI District: Shingleton

Survey Year TOTALS	1985	1986	1987	1988	1989	1990
Early Larval		204	6	4		
Late Larval		7	0	0		
Pupae		25	0	0		
Time (min:sec)		20:00	5:00	5:00		
Adult	4	5	4	6		
Ground Defoliation		LIGHT	LIGHT	LIGHT		
Aerial Defoliation		LIGHT	LIGHT	LIGHT		

JACK PINE BUDWORM SURVEY TOTALS

Township: T47N Range: R12W Section: 31 Plot Number: 13
County: Luce Location: N Danaher Plains Rd
Compartment: 94 Stand: 27 Ownership: State
Timber Type: J6 State: MI District: Newberry

Survey Year TOTALS	1985	1986	1987	1988	1989	1990
Early Larval				9		
Late Larval				11		
Pupae				3		
Time (min:sec)				5:00		
Adult				7		
Ground Defoliation				LIGHT		
Aerial Defoliation				MOD		

Township: T49N Range: R11W Section: 25 Plot Number: 14
Township: T49N Range: R10W Section: 30
County: Luce Location: S of CO416
Compartment: 19 Stand: 55 Ownership: State
Timber Type: J6 State: MI District: Newberry

Survey Year TOTALS	1985	1986	1987	1988	1989	1990
Early Larval		3	1	1		
Late Larval		7	2	3		
Pupae		1	0	0		
Time (min:sec)		5:00	5:00	5:00		
Adult	10	17	0	7		
Ground Defoliation		NONE	LIGHT	LIGHT		
Aerial Defoliation		LIGHT	LIGHT	LIGHT		

Township: T49N Range: R10W Section: 13 Plot Number: 15
County: LUCE Location: SW of CO410 & CO412 Intersect
Compartment: 30 Stand: 13 Ownership: State
Timber Type: J6 State: MI District: Newberry

Survey Year TOTALS	1985	1986	1987	1988	1989	1990
Early Larval		0	2	0		
Late Larval		0	1	2		
Pupae		1	0	0		
Time (min:sec)		5:00	5:00	5:00		
Adult	3	7	4	15		
Ground Defoliation		NONE	LIGHT	NONE		
Aerial Defoliation		LIGHT	LIGHT	LIGHT		

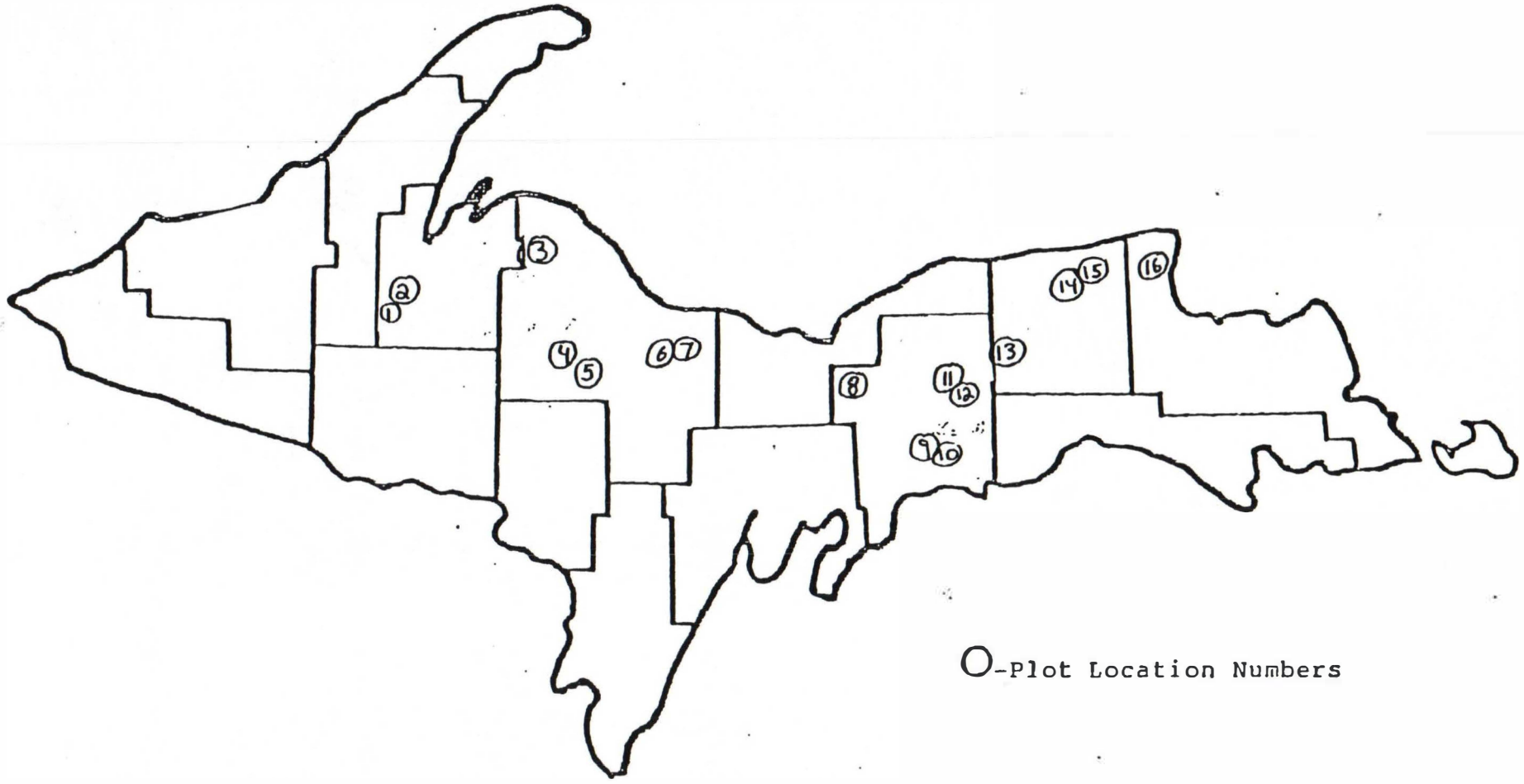
JACK PINE BUDWORM SURVEY TOTALS

Township: T49N Range: R6W Section: 19 Plot Number: 16
County: Chippewa Location: SE of Station South Rd & M123
Compartment: 65 Stand: 19 Ownership: State
Timber Type: J6 State: MI District: Newberry

Survey Year TOTALS	1985	1986	1987	1988	1989	1990
Early Larval		120	28	3		
Late Larval		11	10	12		
Pupae		25	0	1		
Time (min:sec)		35:00	5:00	5:00		
Adult	2	9	6	6		
Ground Defoliation		LIGHT	LIGHT	LIGHT		
Aerial Defoliation		LIGHT	LIGHT	LIGHT		

FIGURE 3

MAP OF MICHIGAN'S UPPER PENINSULA SHOWING PLOT LOCATIONS



ADULT TRAP LOCATIONS AND DATES *
1988

SITE	LOCATION **	DATE OF PLACEMENT	DATE OF RETRIEVAL
1	C, W, NW	8-19-88	7-6-88
2	C, S, W	8-19-88	7-6-88
3	C, SW, S	8-19-88	7-6-88
4	C, SE, SW	8-19-88	7-6-88
5	C, S, SE	8-19-88	7-6-88
6	C, S, E	8-19-88	7-7-88
7	C, NW, NE	8-19-88	7-7-88
8	C, N, E	8-22-88	7-7-88
9	C, NW, N	8-22-88	7-7-88
10	C, S, W	8-22-88	7-7-88
11	C, NNE, NNW	8-22-88	7-8-88
12	C, W, SW	8-22-88	7-8-88
13	C, N, E	8-22-88	7-8-88
14	C, SW, S	8-22-88	7-8-88
15	C, W, NW	8-22-88	7-8-88
16	C, SE, SW	8-22-88	7-8-88

* Trap trees lined with either orange or red paint.
** Both directions read from center.

JACK PINE BUDWORM IMPACT PLOT SYSTEM

Fifteen permanent impact plots were established in major jack pine areas throughout the U.P. in 1984. Thirty-six more plots were established in 1985, bringing the total number of plots to 51.

Plots were placed in groups of 3 spaced 5 chains apart. All plots were at least 3 chains from secondary roads. Plot locations were mapped and plot trees marked permanently with coded metal flags. Each plot consists of 30 trees from which the following data is collected:

PLOT NUMBER
TREE NUMBER
TREE HEIGHT
% OF TREE WITH CROWN
TREE DOMINANCE
CONDITION OF TREE/CROWN
DEFOLIATION CLASS
BASAL AREA (10 baf prism)

Defoliation Class is an ocular estimate of the percent foliage damaged or lost. When trees suffer the loss of both new and old growth, damage increases considerably. A system of estimation and designation of defoliation on new and old growth was used. After careful examination with binoculars and with the unaided eye, individual trees were ranked according to the percentage missing new and old growth (Table 1).

Table 1. Classification of jack pine budworm defoliation.

Defoliation Class	Class Designation	% New Growth Consumed	% Old Growth Consumed
Light	1	0 - 25	0
Moderate	2	26 - 75	0 - 25
Heavy	3	76 - 100	10 - 25
Severe	4	100	26 - 75
Extreme	5	100	75 - 100

Plots were established in the Baraga, Ishpeming, Gwinn, Newberry, Shingleton and Sault Ste. Marie Forest Areas. As the current epidemic progresses, tree losses will be monitored as they relate to the aforementioned variables.